CALIFORNIA DIVISION OF MINES AND GEOLOGY

SUPPLEMENT No.2 TO FER-161

Northern Segment of the White Mountains Fault Zone, Mono County, California

by

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INTRODUCTION

The purpose of this report is to provide additional data on the recently active traces of the White Mountains fault zone (northern segment) in the Montgomery Peak SW and White Mtn. NW 7.5-minute quadrangles. Based on initial observations of scarps in alluvial fans at Marble and Rock Creeks by this writer, T.C. Smith made a detailed interpretation of aerial photographs in order to map the recently active traces of the White Mountains fault zone. His interpretations in the Montgomery Peak SW and NW quadrangles, along with recommendations for zoning, are presented in FER-161 (Smith, 1984). Subsequent photo interpretations revealed recently active traces extending to the south into the White Mtn. 7.5-minute quadrangle, but zoning was not recommended (Hart, 1984). Both of these investigations were conducted with-out field checking, because of time constraints.

Subsequent interpretations of aerial photographs were made and selective field mapping was done by this writer in late April and May. Field assistance was provided by G. Borchardt and W.A. Bryant on May 24, 1984. The results of this work are largely summarized on Figure 6 (Montgomery Peak SW quadrangle) and as additional notations on Figure 5 of Supplement No. 1 (Hart, 1984). Field observations were limited to the Marble Creek-Falls Canyon segment of the fault, which is present below under Localities, 1, 2, and 3.

INTERPRETATIONS OF AERIAL PHOTOGRAPHS; SUMMARY OF PREVIOUS WORK

The geomorphic features observed on aerial photographs (USBLM, 1977) in the Montgomery Peak SW quadrangle are similar to those observed by Smith (Figure 2B, 1984) with the following exceptions: 1) Active traces of the fault could not be identified north of Sec. 14, T.1.S., R. 32 E. (proj.) in the Montgomery Peak SW quadrangle; 2) active traces of the fault could be traced a short distance south of the Montgomery Peak SW quadrangle to about Falls Canyon in the White Mtn. NW quadrangle.

Between Falls Canyon and the Morris Creek fan (Figures 5 and 6), the White Mountains fault zone is generally recognized as being a late Quaternary normal fault based on the steep west-facing escarpment of the White Mountains. Although Crowder and other (1972) and Crowder and Sheridan (1971) map westerly-dipping faults and shears in bedrock along the western margin of the mountains, they do not map any traces in the Holocene and Pleistocene alluvial fans. However, Crowder and others (Section B-B') do infer that a westerly strand of the fault offsets these deposits near Montgomery Creek.

As shown by Smith (1984) and on Figures 5 and 6, the evidence for recent surface faulting is somewhat subtle and discontinuous (low scarps and tonals lineaments in young alluvial deposits). The reason for this may relate to the high rate of alluvial fan deposition in combination with the lack of faulting in the last few thousand years.

It is not clear whether recent activity along the White Mountains fault zone extends northeastward around the northern front of the White Mountains, as indicated by Smith, or whether it simply dies out to the north. These alternatives cannot be evaluated because late (?) Holocene alluvium from Morris Creek and other drainages apparently conceal the location of the surface trace (Figure 6, herin; Figures 2A and 2B, Smith).

The active traces of the fault zone also become less well-defined to the south in the White Mtn. NW quadrangle, just south of Falls Canyon (Figure 5). Recent traces of the White Mountains fault zone are not identified for the next 15 km to the south, where they are again recognized in the alluvial fan of Milner Creek (Bryant, 1984).

FIELD OBSERVATIONS

In order to verify that some of the scarps observed on aerial photographs offset young alluvial fans or reveal other evidence of Holocene activity, three localities were examined in the field on May 23 and 24, 1984.

Locality 1. This is a low 2m-high scarp at the head of a young alluvial fan on the north side of Falls Canyon (Figure 5). The fan contains very large boulders, apparently deposited by debris flows. The clasts of light-colored granitic rock are relatively unweathered and soil development is weak, suggesting a Holocene age. The fan surface appears to be offset by a two-meter high, west-facing scarp, although it is possible that the scarp height may have been enhanced by construction of a dirt road or by erosion. This scarp aligns with a high linear scarp in bedrock south of the creek. The bench west of the scarp is capped by an older (higher), fan deposit that has a steep (30°?W) contact with the bedrock. It could not be determined if the older deposit was faulted, however. As viewed from across the creek, the metasedimentary rock units exposed on the south side of the creek dip 45 to 60° W and appear to be faulted and deformed.

Locality 2. A 3 to 4-meter high, west-facing scarp interrupts the upper two surfaces of a nested fan at the mouth of Rock Creek canyon (Figure 6). The scarp is located at the fan apex, which consists of coarse, bouldery clasts of debris-flow origin. The face of the scarp slopes about 20° to 30° (not measured carefully). The next lower fan surface may be warped slightly (1 to 2 meters), suggesting two possible fault-rupture events. The adjacent, innermost, fan surface is very young and is not offset. A second, west-facing scarp about 2 meters high on the second highest surface was noted about 25 meters west of the main scarp. The lack of weathering or desert varnish on the clasts and the apparent lack of a developed soil on the upper fan surfaces strongly suggest a Holocene age for this fan complex. The fan surfaces have been destroyed about 50 meters upstream as a result of the recent stream down-cutting. It could not be determined if the fan deposit south of the creek was faulted, but it is abruptly terminated on the east by steep bedrock slope. As viewed from across the creek, the metasedimentary bedrock units dip 45 to 60° W and appear deformed and sheared.

Locality 3. The apex of a youthful bouldery fan deposit is offset by a north-trending, west-facing scarp on the north side of Marble Creek. The fan surface is composite, consisting of four, nested fan/terrace surfaces with intervening risers. The upper fan surface is vertically offset 4 to 4.5 m at the scarp, which has a maximum slope-angle of 22°. The scarp is somewhat eroded and is partly veneered with weathered granitic slope-wash from small, local debris flows. The scarp crest is relatively sharp and a second subdued crest can be recognized upslope, suggesting two fault-rupture events. The scarp in the adjacent (inner) fan/terrace surface to the south is about 3.5 m high. Although it has a maximum slope angle of only 16 to 17°, it has been modified by erosion and is partly veneered by local slope wash (debris from weathered granite). The scarp does not appear to interrupt the two youngest (inner) surfaces to the south. Only one young fan surface is present south of the creek and it abruptly abuts a bedrock escarpment. However, a higher, older fan-remnant is present 42 m above the base of the escarpment. A high fan remnant also is present on the north side of the creek.

Soil pits were dug in the upper surface of the younger fan in order to estimate the age of the soil developed on the surface. According to Glenn Borchardt (Borchardt and others, 1984), the soil has an "AC horizon with a weak fine subangular blocky structure, but no clay films," indicating an age of 4,000 to 10,000 years. A pit dug in the high fan surface south of Marble Creek revealed 10 YR colors with a "weak to medium fine subangular blocky" structure with a few thin patchy clay films on sand grains in a B horizon. Clasts of pink granite have weathering rinds 2mm thick and an incipient desert pavement veneered the A horizon. Borchardt estimates a 10,000 to 60,000 year age for this soil. Although confident ages cannot be determined based on the limited work done, the estimated ages appear to generally fit the morphology of the scarp and fan, as well as the general degree of clast weathering.

Although the dip of the fault is unknown, the slopes of the fan surfaces affect the measured scarp heights, and the ages of the units are somewhat uncertain, approximate slip rates can be estimated for faulting at Marble Creek. Assuming the fan surface north of the creek is 10,000 years old and is offset by a 60° W-dipping fault, then a dip-slip rate of about 0.5 mm/year can be determined. A slip rate of 0.6 mm/year can be determined for the fault south of the creek, assuming a similar dip and a 60,000 year age.

CONCLUSIONS

Scarps and other features present in young alluvial fans indicate the probable locations of recently active strands of the White Mountains fault zone along base of the western escarpment of the range. The lack of soil development and weathering of debris clasts at Marble and Rock Creeks strongly indicates that the fan deposits are Holocene in age. The presence of steep slopes and sharp crests on these scarps also suggest a Holocene age. Differences in scarp heights at Marble Creek indicate two possible fault rupture events in early Holocene time. Uninterrupted inner fan surfaces demonstrate the absence of faulting in latest Holocene time.

The presence of subtle scarps and other features elsewhere, suggest the locations of active fault traces elsewhere between Section 14 near Morris Creek (Figure 6) and one kilometer south of Falls Canyon (Figure 5). The interpreted traces of recently active faults shown on Figure 6 are similar to those interpreted by Smith (Figure 2B, 1984). However, no clear evidence of faulting could be verified north of Section 14, near Morris Creek.

The high linear escarpment of the White Mountains indicates a fairly large amount of slip along the White Mountains fault during Quaternary time. The rate of slip during late Quaternary time appears comparable to other active faults of the Sierra Nevada fault zone which equals or exceed 0.5 to 1.0 mm/year in places (Clark and others, 1984).

RECOMMENDATIONS

Preliminary Maps of Special Studies Zones (SSZ's) were issued July 1, 1984 for the Montgomery Peak NW and SW quadrangles, based on the work of Smith (1984). As a result of my later work the following recommendations are made:

Montgomery Peak SW quadrangle--only minor changes in the locations of fault traces and SSZ's are recommended based on data plotted on Figure 6.

Montgomery Peak NW quadrangle--no changes are recommended.

White Mtn.NW quadrangle--although an active trace of the White Mountains fault zone apparently extends about a kilometer south of Falls Canyon (Figure 5), no SSZ is recommended at this time as the area is not apt to be developed (see Hart, 1984, for additional discussion).

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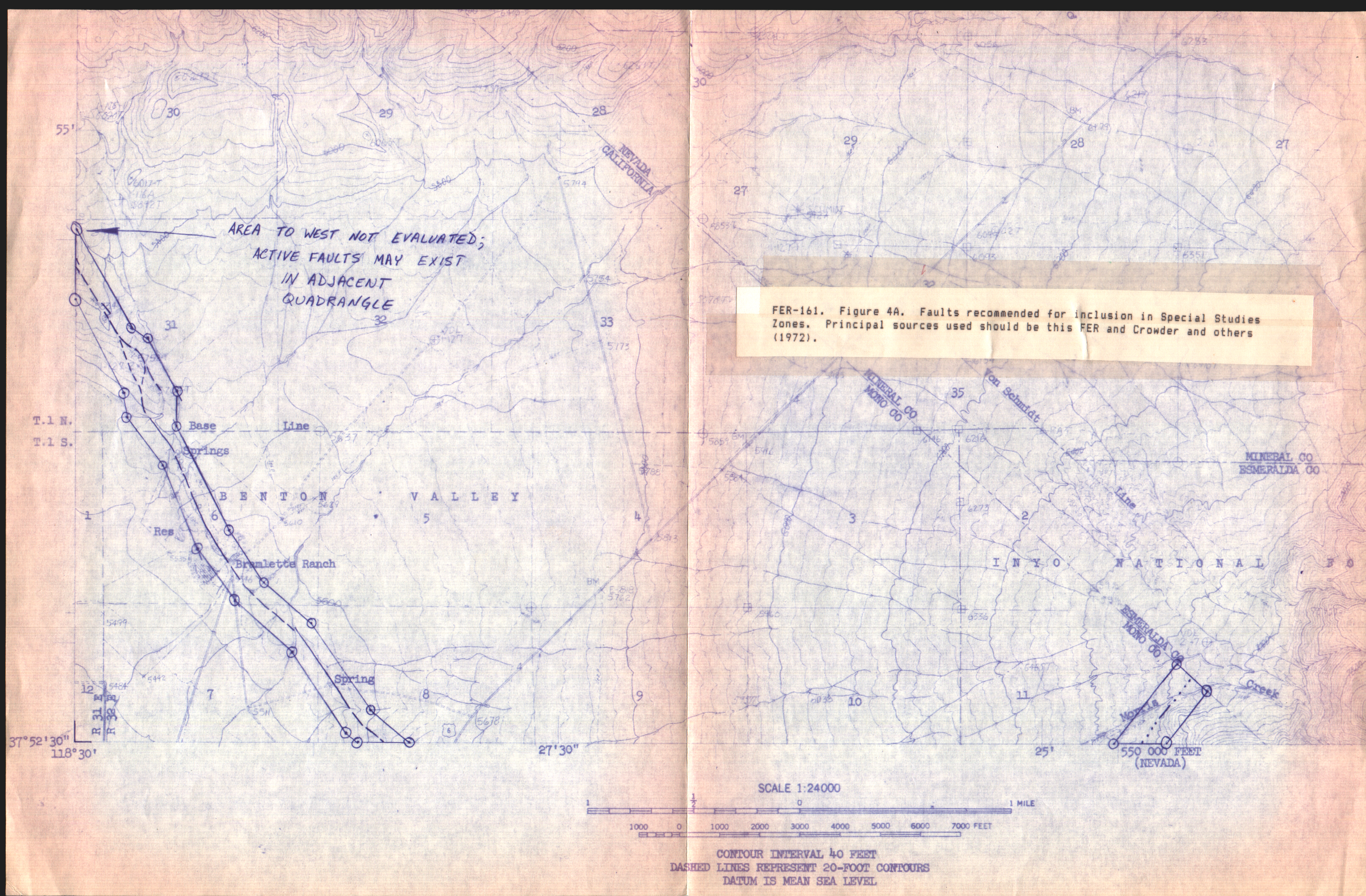

FER-161. Figure 4A. Faults recommended for inclusion in Special Studies Zones. Principal sources used should be this FER and Crowder and others (1972).